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MODIFIED ATMOSPHERE PACKAGING OF PRE- COOKED GRAMS AND SOYBEANS APPLICATION OF DRYING AS AN ADJUNCT

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Pre-cooked foods such as grams and soybeans were either packaged under CO_2 atmosphere or surface-dried in a fluidized-bed dryer, followed by packaging under a CO_2 atmosphere. Carbon dioxide packaging extended the shelf-lives of both products upto six months, compared to controls (without CO_2) which spoiled within 10 days. Chance contamination through delayed packaging reduced the efficacy of the preservative system to 15-30 days (control spoiled within 24 hr.). Sensory scores of both the preserved products were high, though drying caused slightly reduced scores related to appearance (colour).

Key words: Modified atmosphere, Drying, Grams, Soybeans.

Introduction

Modification of atmosphere has been successfully applied to the preservation of various perishable foods such as meats [1,2], poultry [3], seafoods [4], vegetables [5], fruits [6], precooked foods, like cooked beef [7,8] and poultry products [9]. Carbon dioxide the most widely used gas in modified atmosphere packaging (MAP), has been shown effective in controlling aerobic spoilage bacteria [10], facultative anaerobic food pathogens such as *Staphylococcus aureus* and *Salmonella* spp. [11]. The gas also exhibits antifungal activity against the toxigenic fungi such as *Aspergillus flavus* [12] and *Fusarium* spp. [13].

Water activity plays a key role in the fate of micro-organisms, consequently drying, that reduces the water activity of a foodstuff, has certain synergetic effects on the action of preservatives. It has been shown that most bacteria and certain fungi are capable of growing only in conjunction with high water activities ranging from (0.87 to 0.98) [14].

Pre-cooked foods are very popular in the Western world as well as in the far East due to easy handling, time saving and economical superiority. The two varieties of grams *(Phaseolus aureus, P. mungo)* and soybean *(Glycine max)*, are used as traditional staple foods in a variety of Pakistani dishes.

The purpose of this paper was to study the combined effect of CO_2 as a preservative and reduced water activity through drying on the keeping quality of the above foods.

Materials and Methods

Tryptic soy agar with peptone, gas generating envelopes and sodium iodoacetate were obtained from Difco, Oxoid and BDH respectively.

(i) Sample preparation. Soybeans and grams purchased from a local supermarket were washed twice with tap water of pH 7.6, and 1 kg of each of these samples were transferred separately into 3 litre flasks containing 1.5 litre of distilled water (60°). The samples were boiled at atmospheric pressure for 30 min. at 100°.

(ii) Drying. Batches of each sample were dried in a fluidized-bed dryer, Model Retsch Type TG 1 (W. Germany) for 20 min., under the conditions of air flow so adjusted to suspend the material during drying at a temperature of 60° and the temperature equilibration = 5°/min., for 6 min. (above room temperature 30°).

(iii) Packaging under CO_2. Batches of fluidized-bed dried grams and soybeans (a) and samples without drying (b) were made by introducing 50 g of samples after cooking followed by drying into sterile rubber stoppered glass bottles (120 ml capacity). Each bottle was then flushed with 99.5 % CO_2 for 2 min. to completely replace the air, followed by packaging under the same atmosphere (CO_2). Batches of fluidized-bed dried (c) and samples without drying (d) were prepared by holding the bottles in open air for 30 min. after cooking (in order to provide chance of contamination) followed by packaging under CO_2 atmosphere. The controls were prepared without any treatment except cooking.

(iv) Storage. All samples were stored at room temperature (30 ± 4°).

(v) Physical analysis. pH. Sample (1g) was homogenised in 10 ml of 0.15 M potassium chloride (KCl) containing 5 mM sodium iodoacetate (pH 7.4) [15]. The pH value of the homogenate was measured with an Ion 85 ion analyzer / pH meter (Radiometer, Copenhagen, Denmark), using a glass electrode. The pH measurements were taken on day 0, 5, 10, 15 and 30.

Moisture. Outer surfaces of the cooked and dried sample were trimmed off and analyzed on day 0 and 30 for moisture content using an Ultra X moisture tester, type UX 073 (England).

(vi) Organoleptic analysis. Samples were analyzed on days 5, 10 and 15 for overall appearance and odour by a 6-

membered panel who were graduate students and faculty staff members of the Department of Applied Chemistry, University of Karachi. A 14-point descriptive analysis scale was used to score overall appearance and odour [16] starting with the 0 day for reference. The anchor points were defined as "extremely unacceptable" and "extremely acceptable". The scale had a midpoint without a descriptor but was otherwise unstructured.

(vii) Microbiological analysis. Numbers of aerobic and anaerobic Colony Forming Units (CFU)/gram were determined on day 5,10, 15 and 30 by direct plating on Tryptic Soy agar. Sterile, 0.1 % peptone solution was used in the serial dilution. The aerobic CFU plates were incubated at 20° for 72 hr for total numbers and anaerobic CFU plates were incubated in an anaerobic jar using gas generating envelopes, for 48 hr at 20° [17]. These time temperature combinations were found to give better results since high temperature often cause accelerated values of CFU.

Results and Discussions

Treatment (a) and (b). Normal cooking greatly reduced the bacterial load in both the samples of grams and soybeans. Cooking, followed by hot filling and packaging under CO_2 extended the microbiological shelf-life of both the products for 30 days irrespective of product's moisture content (25-30 % moisture for wet and 2-5 % for dried products) indicating that immediate handling may not require reduction of moisture content through drying of the product. Both soybeans and grams displayed best colour / appearance and odour; however dried products showed slightly reduced sensory scores related to appearance (Fig. 1). The pH of homogenates of soybean (pH 6.3) and grams (pH 6.4) did not change during the storage for 30 days. Microbiological analysis showed no aerobic or anaerobic counts during or after this storage. In contrast control samples (no treatment except cooking) spoiled within 24 hr and dried control samples within 15 days of storage. This observation thus confirms the success of cooking and hot filling practice in controlling the microbial load on a foodstuff. Carbon dioxide thus effectively controlled the reduced bacterial number that were achieved by the cooking process in both the dried and undried products.

Treatment (c) and (d). In view of the fact that during commercial processing / handling precooked products may get contaminated, the studies (c) and (d) were designed to evaluate apparent and microbiological shelf lives of these foods, subjected to chances of contamination during commercial processing. Exposure of products to air resulted in a decreased shelf-life of control (1 - 2 d) (not shown in figs.). In contrast samples with treatments (c) and (d) displayed significantly increased shelf lives (Fig. 2). Comparison of treatments c and d also confirm the vital role of reduced moisture in extending the shelf life of CO_2-packaged foods. The decrease in moisture (2-5 %) on the outer layers of products greatly reduced the surface contamination due to air microflora as the protein and carbohydrate form a protective thin film upon heating. The preservative effect of CO_2, however, was not comparable with treatments (a) and (b), due to increased microbial load. Mold growth appeared in samples (treatment c) after 15 to 30 days of storage. Similarly samples after treatment (d) developed bubbles due to gas production within 5 - 7 days of storage. The pH of the homogenates of samples with treatment (c) (soybean, pH 6.3; grams 6.4) remains unchanged but those of samples with treatment (d) reduced to 5.9 in case of soybeans and 5.7 in grams. Sensory scores were higher for samples with treatment c than for samples with treatment d. However, in few replicates colour / appearance of samples with treatment (d) were better than of samples with treatment (c) (before appearance of first bubble) (Fig. 1).

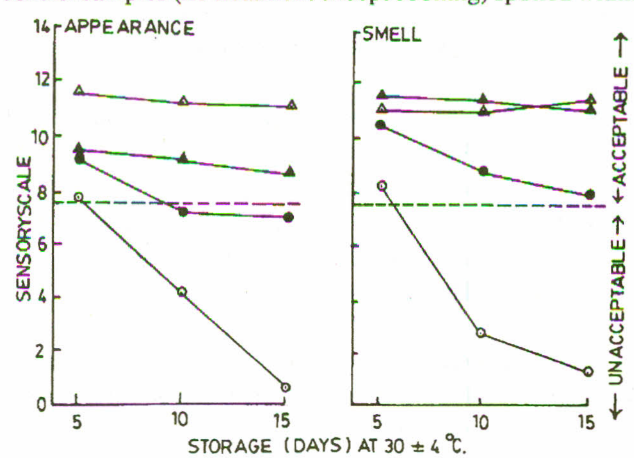

Fig. 1. Sensory scores (average of scores of grams and soybeans): ▲___▲ Cooked dried products package under CO_2 Δ___Δ; cooked wet products packaged under CO_2 ●___● ; cooked dried product exposed to air, Δ___Δ; ; cooked wet product exposed to air, O___O

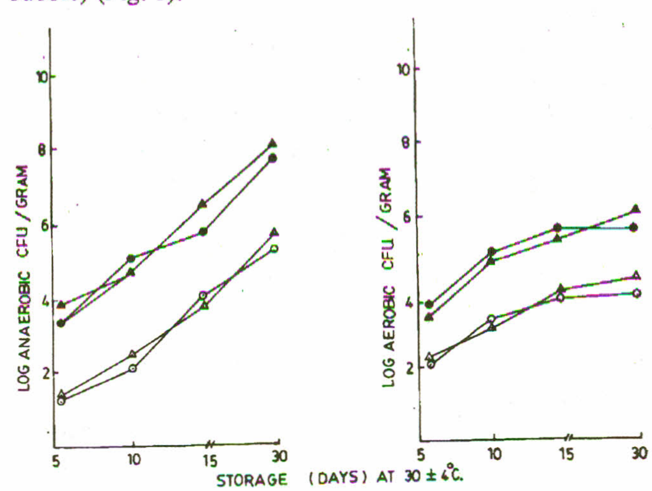

Fig. 2. Treatment c : grams, Δ___Δ ; soybeans, O___O, Treatment d: grams, ▲___▲ ; soybeans, ●___●

From this study it was found that heat processing followed by immediate packaging decreases the possibility of contamination of processed foods such as gram and soybean discussed in this paper. Carbon dioxide successfully limited both aerobic and anaerobic growth, in the case of least contaminated product. Drying may serve as an effective adjunct to CO_2 in preservative models such as that of our. Precooked foods like legumes and cereals can be processed commercially through this simple and effective preservative system. The process is economical as the product storage does not require refrigeration.

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